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Abstract

THE HETEROGENEOUS METHOD AND ITS APPLICATIONS

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Heterogeneous methods for lattice calculations are designed for use in cases where the lattice exhibits irregularities of a type that cannot be handled by the usual homogeneous methods. Such irregularities arise when control rods are inserted between fuel elements, in substitution experiments performed in exponential assemblies, or even in complete lattices containing zones of different fuel spacing as in the case of the Lucens reactor.

The usual two-group or age diffusion theory, in which fuel elements are represented by line sources and sinks, works reasonably well in lattices whose rods are thin compared to their spacing. The cluster elements proposed for D_2O moderated power reactors do not fall into this category, however, and introduce the additional complication of axial and radial streaming.

The heterogeneous method has therefore been extended by incorporating the following features:

(1) Three energy groups covering the fast region, the resonance region, and the thermal region. These groups are needed for two reasons. The first is to define the energy range in which resonance absorption takes place. The second is to introduce a buffer zone between the top group and the thermal group in order to produce a reasonably flat thermal neutron source.

(2) The flux at the fuel surface is expanded into a constant ("monopole")

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term plus a dipole term. The constant term describes the absorption characteristic of the element, the dipole term is required to describe properly the scattering properties of the fuel as well as radial streaming.

(3) Boundary conditions at the fuel surfaces are specified in terms of the linear extrapolation lengths into the fuel. The extrapolation length for the monopole term is well known. The extrapolation length for the dipole term is derived from calculated values of radial diffusion coefficients. Work is in progress to obtain them directly from transport theoretical arguments.

(4) The axial buckling inside a fuel element affects to some extent the linear extrapolation lengths, especially in the presence of voids. These effects are incorporated into the theory in order to account for axial streaming.

(5) The relatively large cluster elements require a more careful treatment of finite rod size than that of assuming line elements and later correcting for the finite rod radius. The present theory treats the finite radius rigorously, but breaks off the resulting series after a few terms.

The entire method is programmed in ALGOL and results will be presented.